To What Extent Can High Frequency Non-Invasive Mechanical Ventilation Reduce Breathing Motion for Liver Stereotactic Ablative Radiotherapy?

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Introduction

Whilst stereotactic ablative radiotherapy (SABR) is generally efficacious and considered the standard of care for primary liver cancer and liver metastases; respiratory motion is a critical challenge impacting precision and accuracy of delivery. A reduction in breathing motion enables a smaller treatment volume, resulting in reduced radiation exposure for neighboring healthy liver tissue and reduced associated toxicities, consequently facilitating a higher dose to the clinical tumour volume (CTV) with higher tumour control probabilities. Current breathing management techniques utilised for the liver have known limitations,

Non-invasive ventilation (NIV) is a novel active motion management technique for radiotherapy where the patient's breathing and consequently breathing motion can be controlled and tailored to the specific application. Here we demonstrate the application of higher-frequency NIV as an active motion management technique to reduce the amplitude of breathing motion for the liver.

Aim

To investigate the use of higher-frequency NIV at 25, 35 and 45brpm to reduce associated breathing motion for liver targets using healthy volunteers.

Materials and Methods

Motion will be assessed by imaging 10 healthy volunteers using magnetic resonance (MR) T1-weighted 2D orthogonal interleaved cine images in the sagittal and coronal planes, centered over the portal vein in the liver. The volunteer will be ventilated using a Hamilton T1 ventilator with 21% oxygen at free breathing, 25, 35 and 45brpm, imaging for 5 minutes at each frequency. Portal vein motion will be tracked using an in-house python code. To evaluate reproducibility the process will be repeated at a second time point.

Results

This study is in the data acquisition phase. Preliminary data demonstrates decreased portal vein motion associated with higher frequency brpm, although with a potential drift of the target. Early analysis suggests 35brpm may be optimal. Data acquisition will be completed throughout March 2026.

Conclusion

The demonstration of NIV in facilitating motion reduction for liver targets would increase access to more therapeutic treatment in patients where breathing motion limits the available treatment.